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RESEARCH MEMORANDUM

A TIME HISTORY OF CONTROL OPERATION OF A C-54 AIRPLANE IN BLIND LANDING APPROACHES

By

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NATIONAL ADVISORY COMMITTEE
FOR AERONAUTICS

WASHINGTON

July 18, 1947

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A TIME HISTORY OF CONTROL OPERATION OF A C-54 AIRPLANE IN BLIND LANDING APPROACHES

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SUMMARY

Tests were made with a C-54 airplane in which airline pilots made several blind approaches to determine whether any special flying techniques were used in blind landings and whether any special handling-qualities requirements would have to be formulated because of such special techniques.

It was found that the airplane was flown at all times in the normal manner; that is, all turns were banked turns that were nearly coordinated by use of the rudder so that the sideslip was held close to zero. The pilot expended considerable physical work in continually moving the controls but this wake was due in part to the large friction in the three control systems. The actual control deflections used were small compared to the maximum deflections available.

INTRODUCTION

In October of 1946, flight tests were begun on a C-54 airplane which had been instrumented completely with standard NACA recording instruments to measure its handling qualities. During the course of these tests, three regular airline pilots made several blind approaches. An Army operated GCA (ground-controlled approach) blind-landing system was used. The object in making these blind approaches was to determine whether any special flying techniques were used under such conditions and whether any new handling-qualities requirements would have to be set up because of these special techniques.

RESULTS

A time history of one of the approaches is given in figure 1. The curves of figure 1 are tracings of the continuous photographic records from the standard NACA recording instruments except for the

curves showing heading, distance from the center line of the runway, and the angle of bank. These three curves were obtained from motion pictures of the horizon and runway taken by a camera that was mounted rigidly in the nose of the airplane and which was synchronized with the other instruments. The three quantities in question were obtained easily from the geometry of the system. Because of a faulty instrument switch, there was an inadvertent break of unknown duration in the record; however, this break was known to be of the order of 5 or 10 seconds. Consequently, separate time scales were used for the two parts of the record shown in figures 1(a) and 1(b). The record was terminated when the pilot, who was flying under the hood, removed his goggles at an altitude of about 150 feet and at a position approximately 2000 feet from the end of the runway.

DISCUSSION

Although figure 1 is a record of only one approach, this figure shows results that are typical of those obtained from all the approaches made. Before these approaches were made, it was thought that pilots might be afraid to bank and would make all heading corrections by sideslipping in flat turns made by use of the rudder. However, it was found that the pilots always flew the airplane in the normal manner; that is, left rudder was coordinated with left aileron and right rudder was coordinated with right aileron when making left and right turns, respectively. Examples of this coordination may be found at 32, 42, and 60 seconds in the illustrative time history of figure 1(a), and at 42, 62, and 100 seconds in the part of the time history in figure 1(b). An examination of figure 1 and records of all the other blind approaches made showed that the maneuvers never required the application of more than $\pm 10^\circ$ total aileron, $\pm 5^\circ$ rudder, and $\pm 2^\circ$ elevator control. The total control deflections available were $\pm 26^\circ$ total aileron; $\pm 20^\circ$ rudder; and 25° up, 10° down elevator. By reasonably exact coordination of the rudder and aileron controls, the angles of sideslip were held within $\pm 2^\circ$ of zero. Therefore, it appears that pilots normally coordinate the rudder and aileron controls when making blind landing approaches.

It was apparent from the force records that the pilot did considerable physical work by continually feeling out the friction in the control system although he did not move the controls very far. The control friction on the ground was ± 14 pounds for the elevators, ± 13 pounds for the ailerons, and ± 20 pounds for the rudder. These friction forces were considered excessive and were caused in large measure by the hydraulically operated automatic-pilot servounits which contributed about ± 10 pounds friction to each control system.

CONCLUDING REMARKS

From these tests it appears that compliance with the present NACA handling-qualities requirements will be sufficient to insure that the stability and control characteristics of an airplane in blind landing approaches will be satisfactory.

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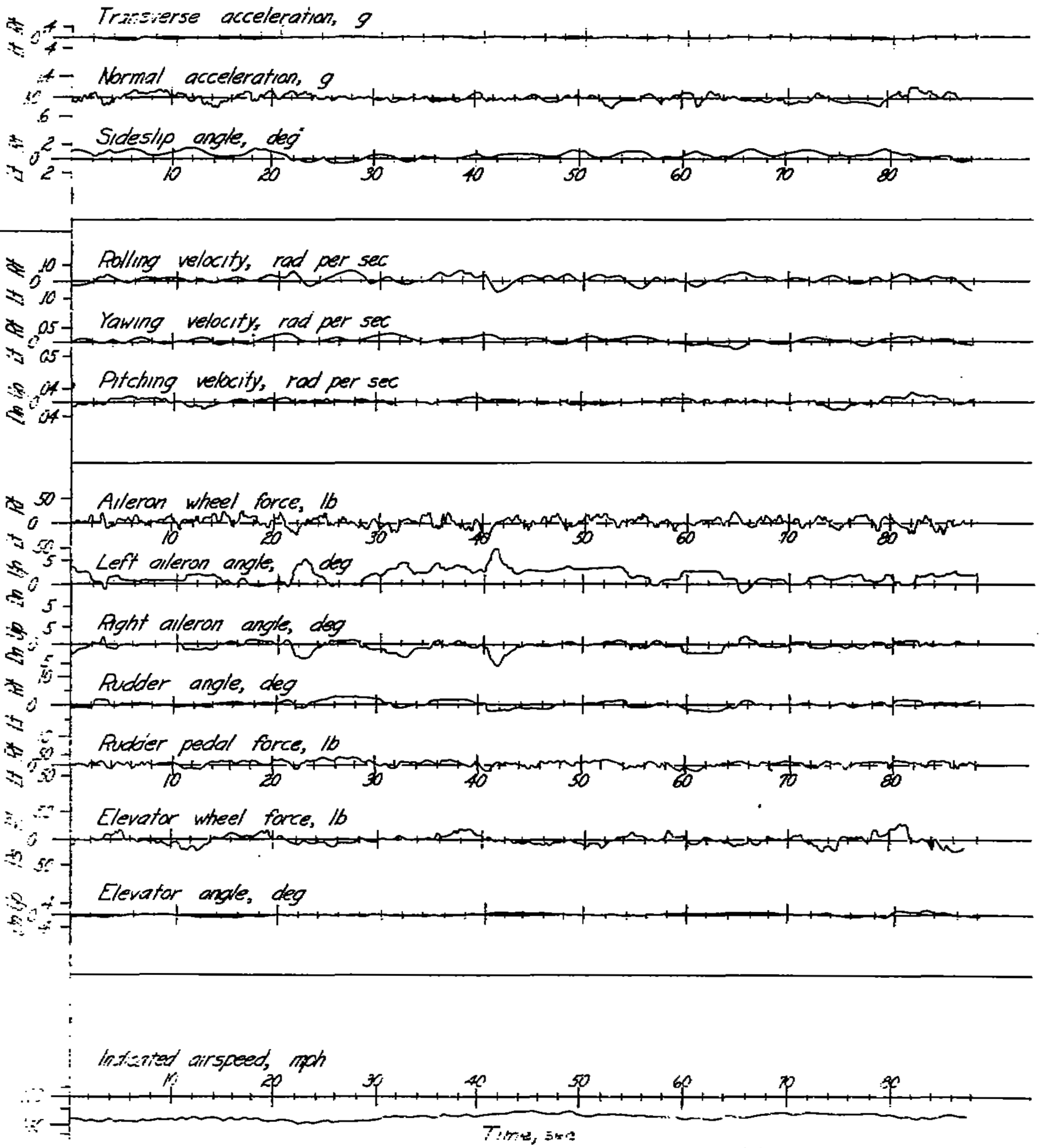
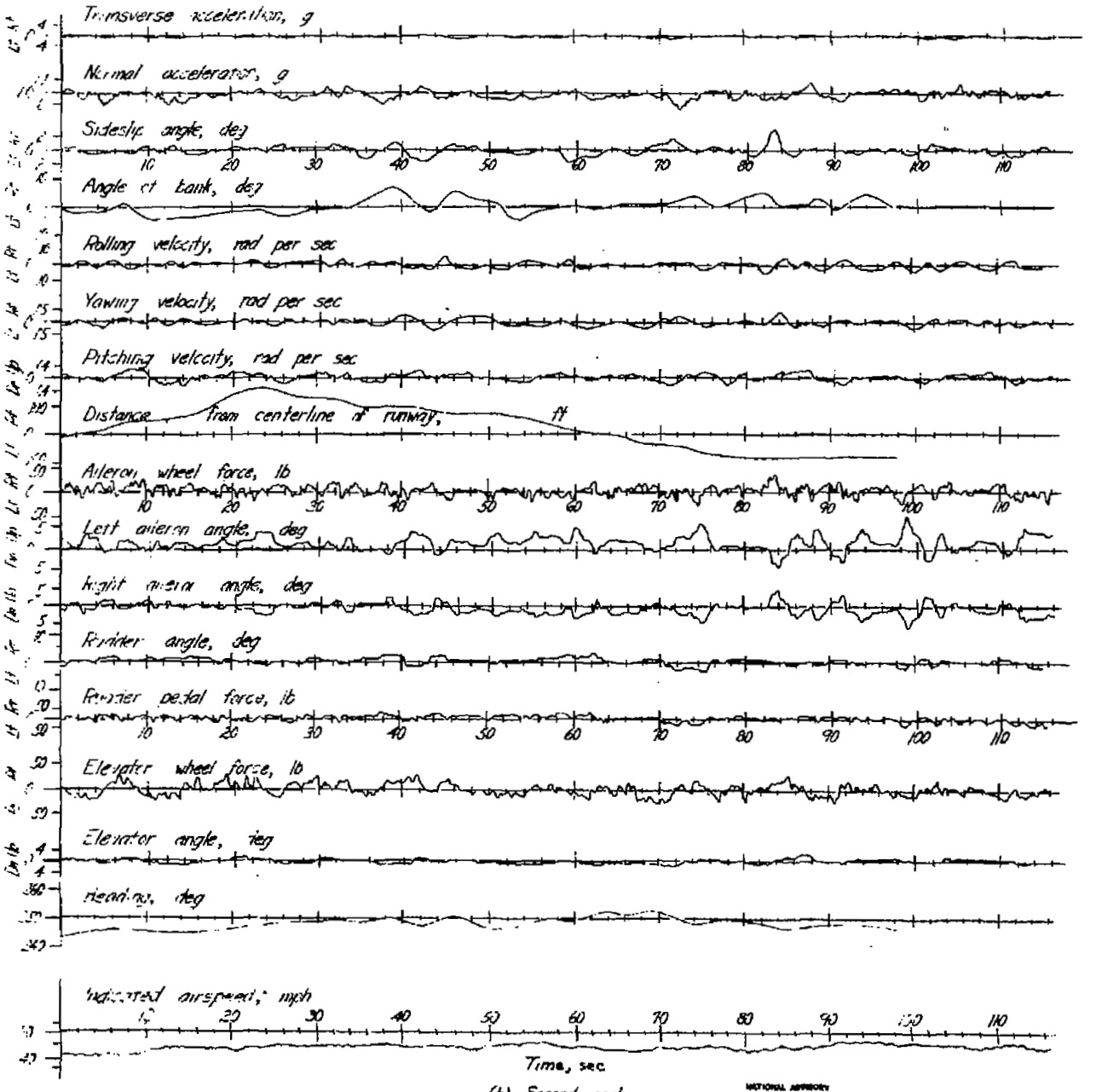


(a) First part.

Figure 1.- [illegible] of a [illegible] landing approach in a [illegible] airplane.



(b) Second part.

Figure 1.- Concluded.

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